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JOURNAL

OF THE

AMERICAN WATER WORKS ASSOCIATION

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VOL. 8 NOVEMBER, 1921 NO. 6

MUNICIPAL STEAM HEATING SYSTEM AT CLEVELAND, OHIO[1]

By H. W. Kaiser[2]

The municipal steam heating system serves a business and residence district about four and one-half miles east of the Public Square, in and around the Euclid and East 105th Street section, as shown on the map, figure 1. It had its beginning at the time just previous to the completion of the Museum of Art in Wade Park in 1912.

In order to dispense with a smokestack in the park, the idea presented itself of heating the Museum with steam from the Fairmount Pumping Station. The distance between the station and the Art Museum was so great that the expense of running a steam line between the two was prohibitive when weighed against the undesirability of having a heating plant in the park. To reach the Art Museum, however, it was necessary to pass very close to the densely populated residence and business section at East 105th Street and Euclid Avenue. It was then decided to sell steam to consumers in that vicinity, in order that they might assist in financing the project.

Accordingly, a canvas was made of the district, and prospective consumers were asked to sign an application for service, pledging themselves to buy steam from the city, provided the line was installed.

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[1] Read at the Cleveland Convention June 7, 1921. Discussion is invited and should be sent to the Editor.

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As a result of this survey, estimates were based upon the distribution and sale of steam at a maximum of 2500 boiler horse-power.

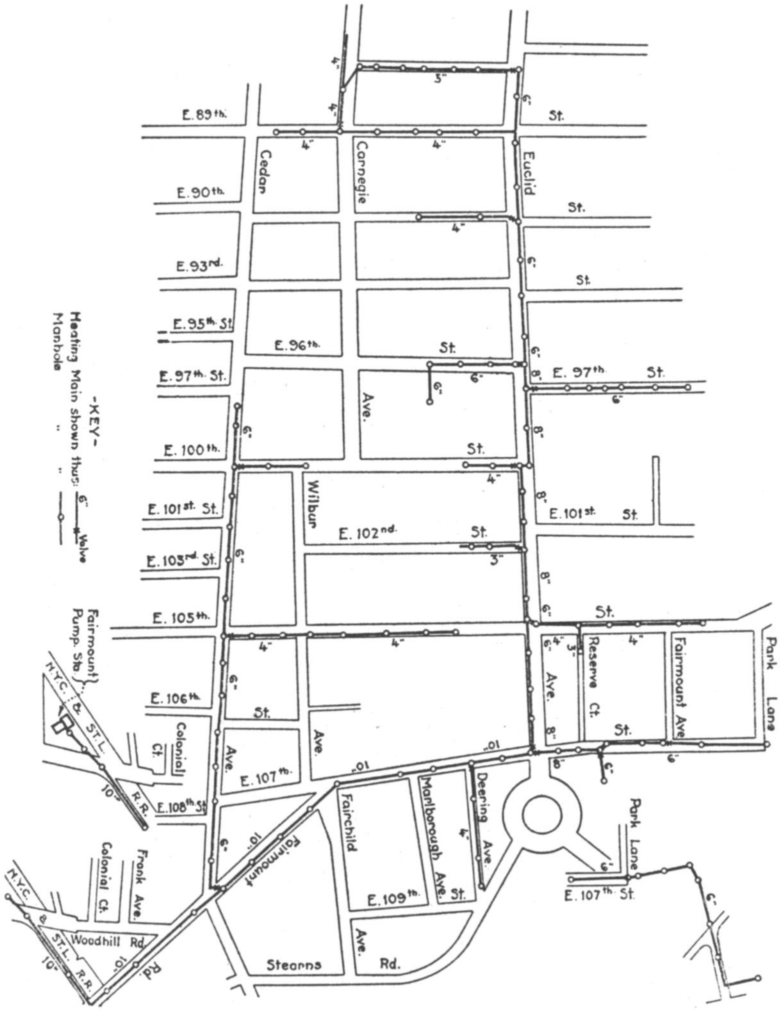


FIG. 1. MAP OF MUNICIPAL HEATING SYSTEM

The estimated cost of preparing the boiler plant for the additional load, and of installing the pipe lines was completed and presented to Hon. Newton D. Baker, the Mayor, who brought the subject before the Council.

On July 15, 1912, an ordinance was passed by the Council appropriating $50,000 for additions to the boiler house and equipment of Fairmount Pumping Station, and for the installation of pipe lines for municipal steam heating purposes. Work was immediately started on the underground mains and on the additions to Fairmount Pumping Station boiler house and equipment.

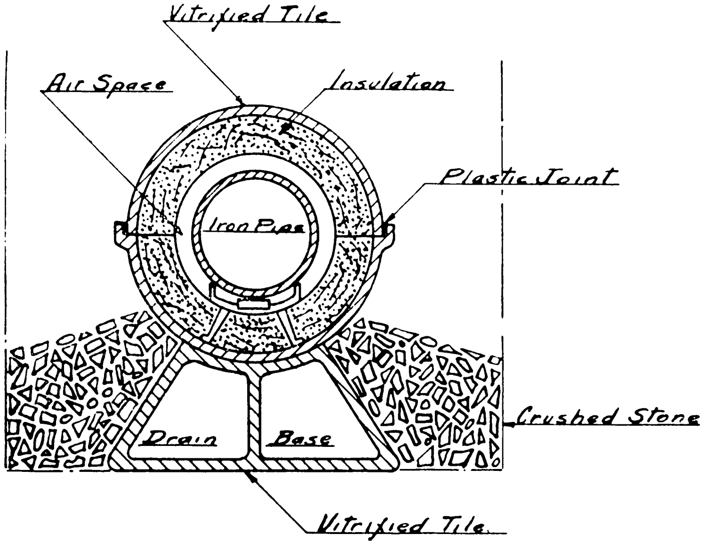
Since all pumping station equipment was designed for condensing operation, and no exhaust steam was available for heating purposes, and also due to the great distance between the pumping station and the center of distribution, it was obvious that steam should be conducted and distributed at high pressure. This permitted the use of very much smaller pipe with the resulting lower pipe and pipe covering costs than if low pressure steam were used.

Steam was turned into the heating mains in September, 1912, but the revenue derived from the sale of the steam for the first three months was very small. Most of the steam generated during this interval was used for testing and experimental work on the services. For this reason, the cost of operating the heating plant up to January, 1913, was charged to construction. The total of all construction charges to that date was $48,700.

During the year of 1913, contracts to the amount of $159,500 were let for additions to the boiler house and equipment. Up to January 1, 1914, about half the work covered by these contracts was completed, and by the end of the year practically all of the new equipment was installed and in operation. For this reason, January 1, 1915 has been used as the starting point in computing the life of the plant.

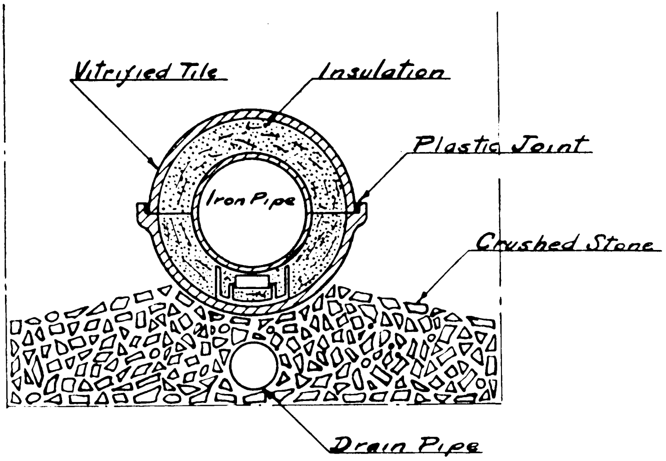
The length of line installed the first heating season was about 8200 feet and served approximately 176,000 square feet of radiation. Manholes for expansion joints were installed about 400 feet apart. Halfway between the joints the pipe was rigidly anchored to a heavy concrete block. From the anchors to the expansion joints the pipe was carried on rollers in an absolutely straight line. Wherever there was a bend in either a horizontal or vertical direction, the pipe was again anchored securely enough to take care of any thrust due to unbalanced pressure.

When the lines were laid, two kinds of covering were used, the principal constituent of each being magnesia. One type of covering was moulded in half of a tile pipe, which formed the protective cover for the top and bottom. Since the covering was somewhat larger



TYPICAL SECTION OF STEAM MAIN

FORMER INSTALLATIONS.



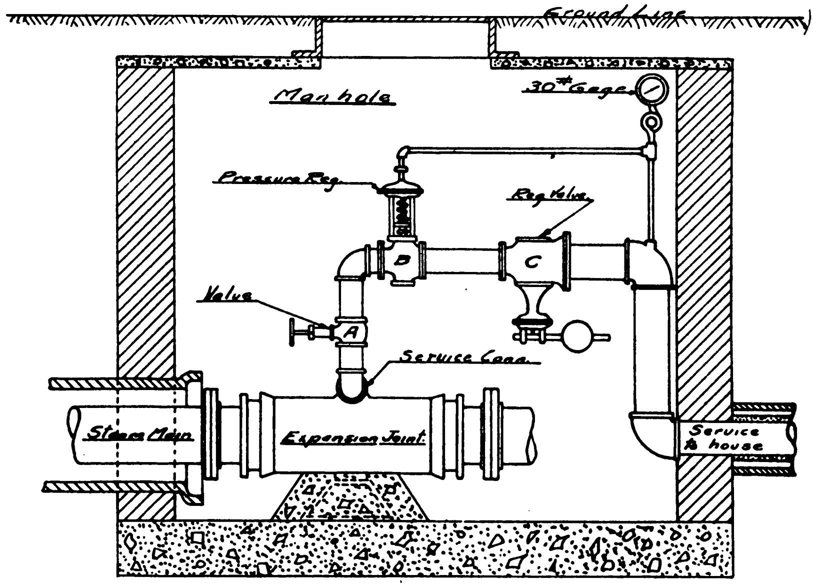
TYPICAL SECTION OF STEAM MAIN

PRESENT INSTALLATIONS.

Fig. 2.

than the outside diameter of the steam main, an air space was left between the line and the insulation. This method proved impractical, as moisture caused the covering to disintegrate and fall to the bottom of the tile, forming a soggy mass.

The second type of covering was sectional magnesia which fit snugly around the steam line, eliminating the air space. This covering was protected above and supported below by a split tile pipe, similar to ordinary sewer pipe, except for a longitudinal flange on the lower half. This tile pipe was supported on a bed of crushed stone, in which a drain pipe was laid. This tile together with the crushed stone kept the line properly drained.

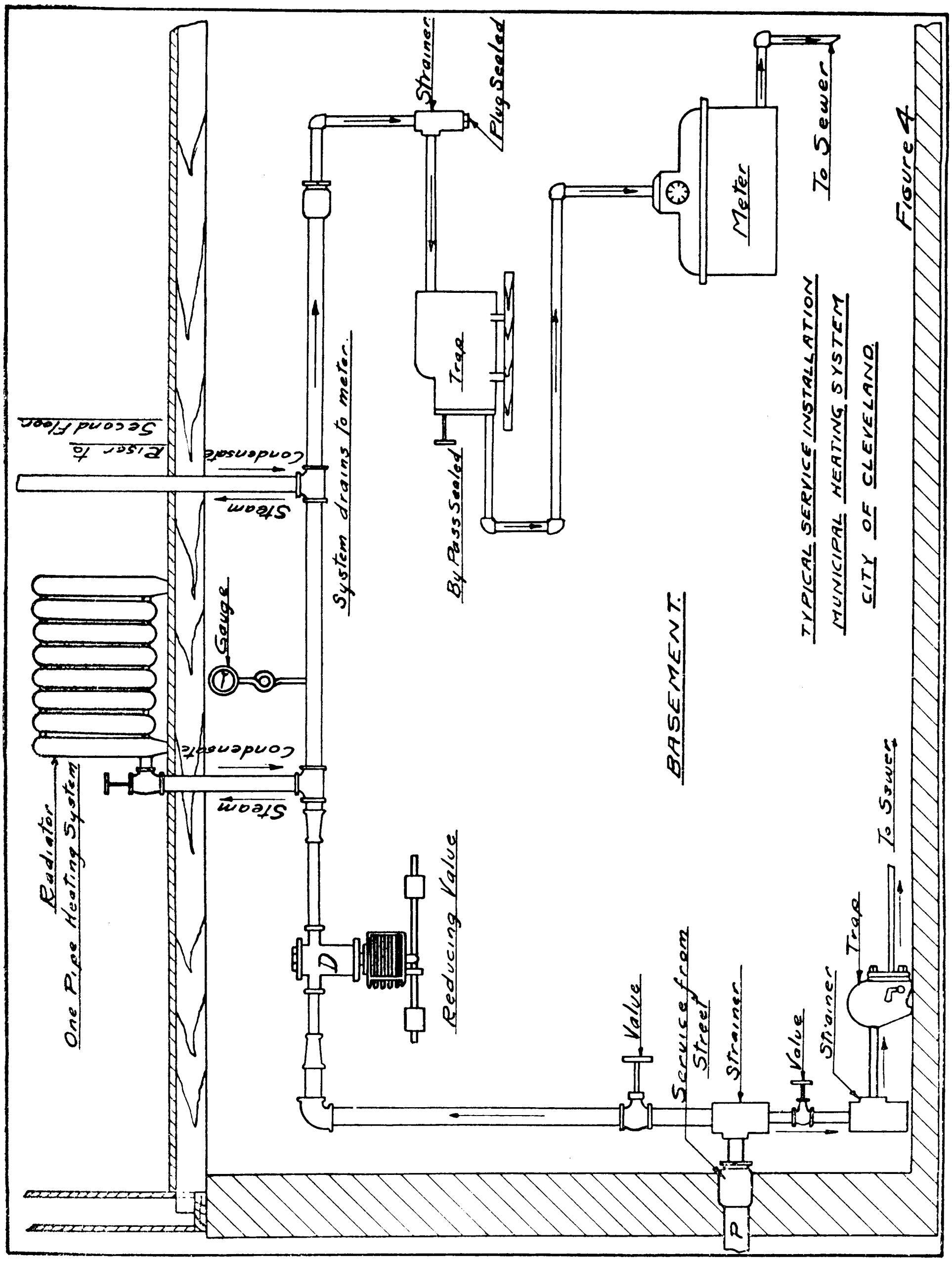


TYPICAL MANHOLE.

Note: All of service covered as far as house

Figure 3

This method of installation is still being used, except that an asbestos sponge felted sectional covering is used instead of a magnesia covering.



TYPICAL SERVICE INSTALLATION
MUNICIPAL HEATING SYSTEM
CITY OF CLEVELAND

Figure 4

All mains and services are about 5 feet below the surface.

The sketch of the manhole, figure 3, shows a typical piping arrangement in a manhole for connecting to a service installation, serving one or more consumers. The steam passes first through a shut-off valve (*A*). Next we have two reducing valves (*B*) and (*C*) in series. The two valves are set for the same pressure, the second functioning only on failure of the first one. These valves are set at pressures ranging from 10 to 22 pounds, depending upon the number and kind of consumers served. The second valve is tested regularly by an inspector, who does so by holding the first valve open until the pressure in the service main builds up to the desired point. This prevents any high pressure steam from entering the consumers' premises. These service connections are installed and covered in the same manner as the mains.

The steam enters the house from the manhole, figure 3, to the basement through a low pressure line (*P*), figure 4, and passes through a third reducing valve (*D*). This valve can be set at any predetermined pressure depending upon the requirements of the individual user.

In some instances an automatic thermostatic control is used in connection with this valve. After passing this point the steam goes through the system, the condensate returning through the same line except where the separate return pipe system is used. The lines are all pitched toward the meter. The condensate returns first to a trap and then discharges into the meter and then to the sewer. These meters are read every month and consumers billed accordingly.

Before being sent into the distribution system, the steam is metered in the station by General Electric Type F S—4 flow meters, figure 5. The piping is so arranged that either a 4-inch, 6 inch, or 8 inch supply line may be used as the quantity of steam may require. The Pitot tubes for each meter are inserted in the proper lines just above the valve which controls the line. Different size supply ines are used so as to maintain a velocity head large enough to register accurately on the flow meters. It is evident that when the demand for steam is small, the use of a 4-inch line would give a better registration on the meter than could be obtained with an 8-inch line.

Just before the steam leaves the station, it passes through a 6-inch reducing valve. This valve operates quite satisfactorily in mild weather, when the quantity of steam used is small. In severe weather it does not permit the steam to pass fast enough, and a by-pass must be used. It is our intention to replace this meter before the next heating season with a reliable reducing valve of sufficient size to operate satisfactorily under all conditions.

Under average temperature conditions the steam leaves the station at about 100 pounds gage pressure, dry and saturated. This pressure is increased to 125 pounds in severe weather and decreased to about 60 pounds in mild weather. With this initial pressure, the final pressure in the extreme ends of the high pressure mains is about 30 pounds. There is a reducing valve at the beginning of every low pressure branch line. These valves cut the pressure down to about 22 pounds or less, depending upon the length of the low pressure line, and the kind of consumers it serves.

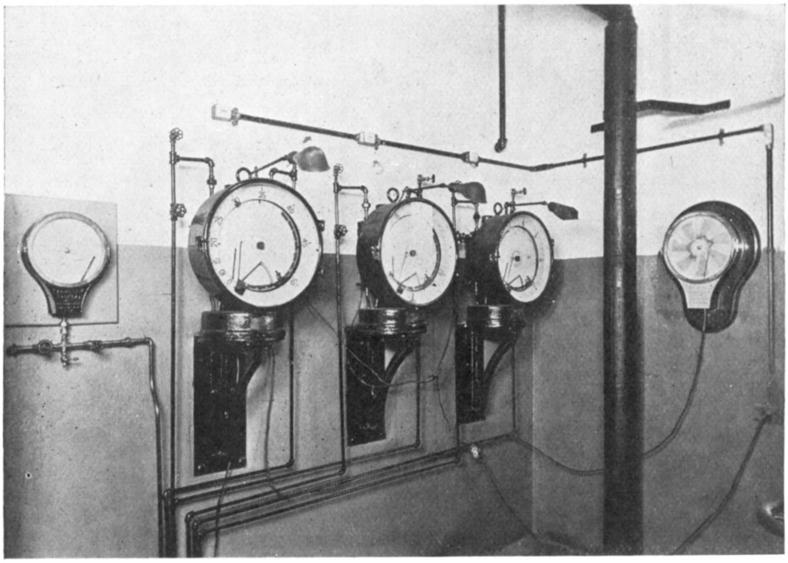


Fig. 5

At the present time there are about 206 consumers on the line, the total heating surface being approximately 270,000 square feet.

The Elysium, an artificial ice skating rink, located near Wade Park, uses steam at approximately 85 pounds pressure for driving refrigerating machinery of approximately 100 horsepower.

The characteristic condensation curve, figure 6, for the heating system, plotted from averages of five years, shows that in mild weather there is a greater percentage of steam lost than in severe weather. This is due to the fact that the amount of condensation is practically the same from month to month regardless of temperature changes. At the beginning and end of the heating season, when a small amount of steam is being used, the percentage of condensation loss is, therefore, larger than during the colder period when a greater quantity of steam is supplied.

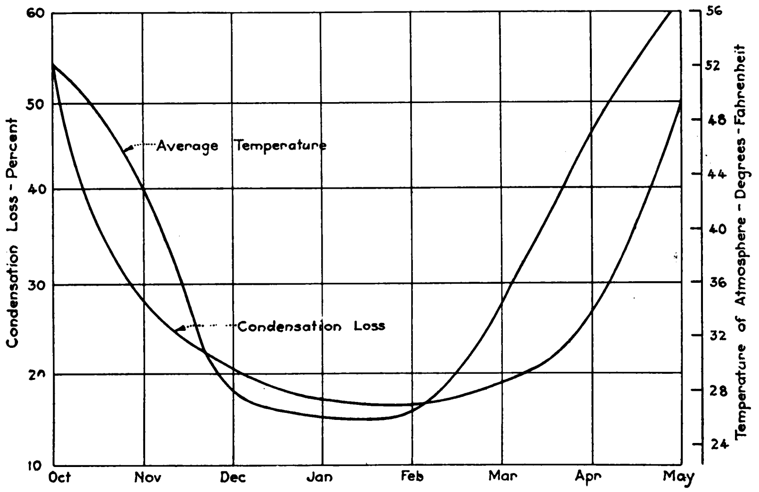


FIG. 6

You will note that the curve of average temperatures during the heating season, has the same characteristics as the curve showing condensation loss.

The curves, figure 7, show graphically the relation between the amount of steam delivered to the heating system, and the amount recorded on the consumers meters. For the period of years shown, an average of 75.3 per cent of the steam delivered to the heating system was recorded on meters of consumers. The difference is accounted for by meter under-registration and condensation in the mains. The greatest loss during the six year period occurred in May when only 50.32 per cent was recorded, and the smallest loss was in December, 81.5 per cent being metered during this month.

It will be noted that the demand for steam has decreased since 1917, while the number of square feet of radiation has increased. This was caused by a decided increase in the cost of the steam to the

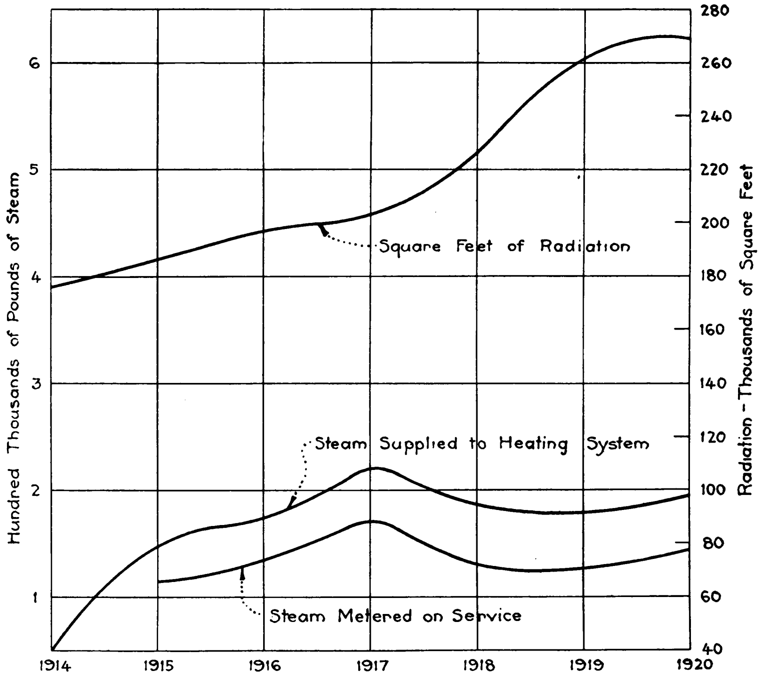


Fig. 7

consumer. This had the effect of causing each consumer to pay closer attention to his use of steam, with a view to keeping it as low as possible.

When the heating system was first installed, the rate charged the consumer was as follows:

	per month
35 cents per 1000 pounds of steam for the first	300,000
30 cents per 1000 pounds of steam for the next	1,200,000
25 cents per 1000 pounds of steam for all over	1,500,000

All bills were subject to a discount of 10 per cent if paid within 10 days, and a penalty of 3 per cent if paid after 10 days. This rate schedule was changed January 1, 1918, to a charge of 75¢ per 1000 pounds of steam used, regardless of the quantity. The 10 per cent discount was retained.

The cost curves, figure 8, show the relation between the amount received for the sale of steam and the cost of producing it. The

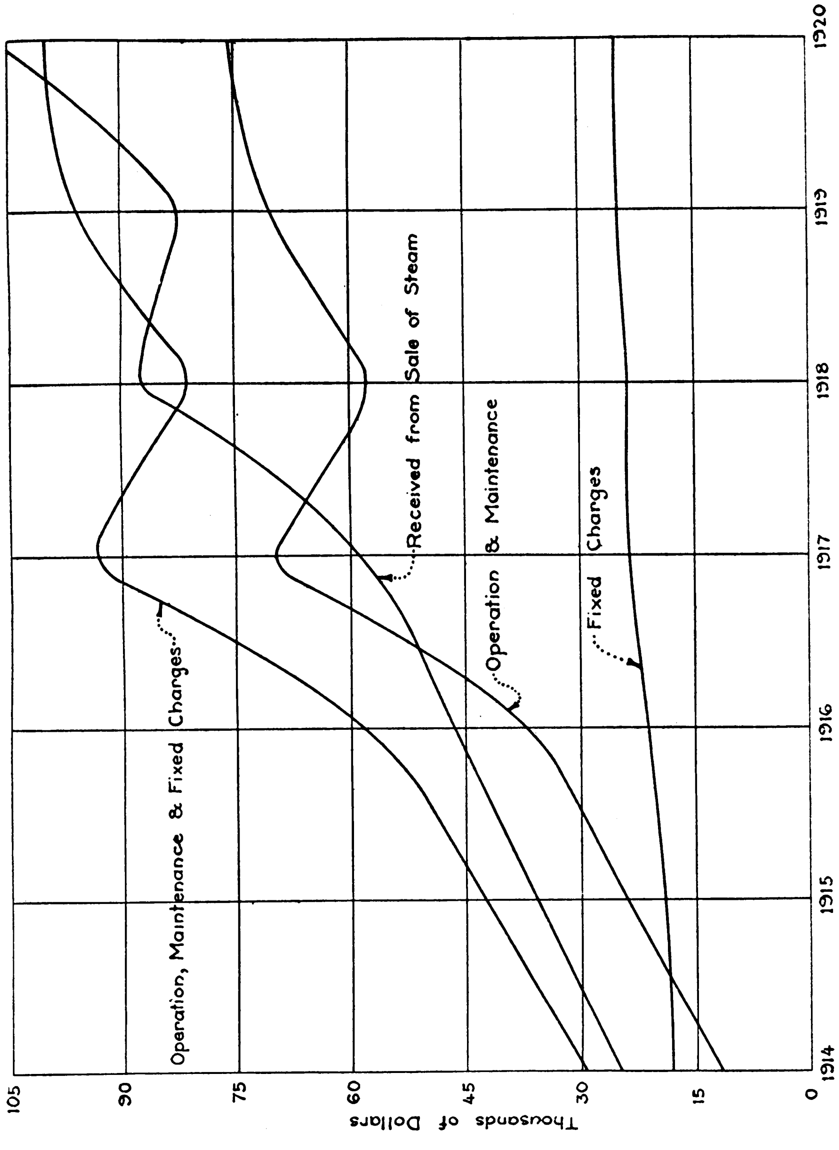

Operation, Maintenance & Fixed Charges
Received from Sale of Steam
Operation & Maintenance
Fixed Charges
105
90
75
60
45
30
15
0
Thousands of Dollars
1914
1915
1916
1917
1918
1919
1920

FIG. 8

amount received for the sale of steam exceeded the operation and maintenance charges until 1917, when the unprecedented increase in the price of coal, labor and supplies forced these costs above the revenue derived. The price of steam to the consumer was increased to meet these rising costs in 1918 and the curves again assumed their proper relationship.

As stated previously, the life of the plant is calculated to be twenty-five years, beginning January 1, 1915, and running until January 1, 1940. The original investment as well as additional investment from year to year, is all intended to expire in 1940. Therefore, the sinking fund and interest are figured on that basis.

As can be seen from the curves, the revenue from the sale of steam was large enough for 1918 and 1920 to cover all the charges against the system and show a profit as well. The other years, the plant operated at a loss.

This fluctuation was caused by the variation in the amount of steam sold, the price at which it was sold, and the price of coal, labor and supplies. Since the cost of these items entering into the cost of steam is now decreasing, and our steam consumption is again increasing, we should be able to operate at a profit every year.